

Pollination of a Canary Tree Flower

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Abstract

Pollination is an essential part of the life cycle of flowering plants. We perform an experiment to determine how long a canary tree flower is accessible to pollinating insects so that fertilization can take place. We conducted an observational study where we measured the size of the same flower and charted its growth each day. With the observational data we constructed a scatter plot and from the graph we fit a cubic function to the data. We conclude that in the lifespan of a canary tree flower, pollination begins at $5 \frac{1}{2}$ days and ends approximately 9 days later.

Keywords

Newton's Method, Curve Fitting, Pollination

TABLE OF CONTENTS

Problem Statement.....	3
Motivation.....	3
Mathematical Description and Solution Approach	4
Discussion.....	5
Conclusion and Recommendations	6
References.....	6

PROBLEM STATEMENT

What is the average number of days that a flower is able to be pollinated?

MOTIVATION

This problem is useful to botanist and horticulturist communities because pollination is essential to the reproduction of all flowering plant life. Without it we would not have fruits, vegetables or seeds for new plants to grow. There are two methods of pollination. One is self-



Figure 1: Bee pollinating a canary tree flower

pollination which happens within a single flower. The pollen from the male anther drops down to the female stigma and fertilization occurs. This type of pollination occurs within simple flowers that have no color or smell to attract wildlife. The more common form of flower fertilization is cross-pollination. These flowers are typically colorful or fragrant to attract insects and other wildlife. The honey bee

was the most observed pollinator. When pollinators travel from flower to flower, pollen will stick to the bodies of these organisms and spread to other flowers. Cross-pollination is important because it provides genetic variation for the species offspring. Genetic variation can create stronger, healthier and more disease resistant plants which is very useful for all gardeners alike.

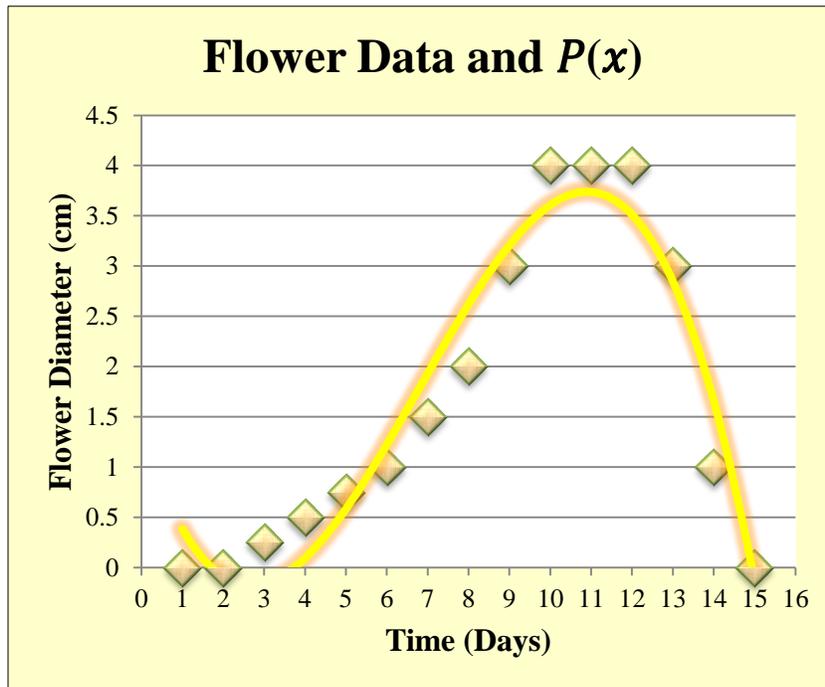
Therefore it is useful for those working in the field of plants to know exactly when cross-pollination can occur. We chose this experiment in order to discover the average time a flower is available to be pollinated.

MATHEMATICAL DESCRIPTION AND SOLUTION APPROACH

We constructed a scatter plot of the data contained in Table 1. Using Microsoft Excel we found the cubic curve which best fits our data to be

$$P(x) = -0.0141x^3 + 0.2869x^2 - 1.2354x + 1.3462 \quad (1)$$

plotted in Chart 1 below.



Day	Diameter of Flower (cm)
1	0.00
2	0.00
3	0.25
4	0.50
5	0.75
6	1.00
7	1.50
8	2.00
9	3.00
10	4.00
11	4.00
12	4.00
13	3.00
14	1.00
15	0.00

Chart 2: Plot of the diameter of a canary tree flower over time and the best-fit cubic model $P(x)$ for the data.

Table 1

During our daily observations we noticed that the pollinating insects could only gain access to the flower when the diameter of the flower was at least 1 *cm*. We use Newton's method to find the values of x that give $P(x) \geq 1$ to determine the length of time the flower is able to be pollinated. Since Newton's method is concerned with finding roots of a given function we define $Q(x) = P(x) - 1$, and apply the method to $Q(x)$. To perform Newton's method we first pick a value $R(0)$ for x that is close to the unknown root. We use the derivative $Q'(x)$ to construct the line tangent to $Q(x)$ at the point $(R(0), Q(R(0)))$. Next, we set $R(1)$ equal to the value of the x -intercept of this tangent line and begin the process again. In general we have

$$R(n + 1) = R(n) - \frac{Q(R(n))}{Q'(R(n))}. \quad (2)$$

We perform multiple iterations of (2) to find a fixed point of the sequence $\{R(n)\}$, and this fixed point is the desired root.

DISCUSSION

Newton's Method yields $P(x) = 1$ when $x = 5.67$ and $x = 14.41$. In the context of our problem we conclude that pollination can begin about $5\frac{1}{2}$ days into the flower's growth and ends approximately 9 days later. Although the data was measured through observation we believe the results to be accurate. The results of the experiment were not surprising; however, the study was informative. The results of this experiment may be useful for botanists and horticulturists, especially those who work with fruit and vegetable production, allowing them to work with greater accuracy and efficiency.

CONCLUSION AND RECOMMENDATIONS

From this study we can conclude that a canary tree flower is available to distribute pollen for 9 days, and within those 9 days the flower itself may be pollinated. It takes about 5 ½ days for a canary tree flower to mature enough to begin reproduction. We assume that pollen is available after 5 to 6 days of flower maturity and that the stigma does not mature until 10 to 12 days of the full flower's maturity. We justify these assumptions based on the fact that after the stigma is fertilized by the pollen the flower has no other purpose to stay open. Therefore we can conclude that actual fertilization occurs at the end of the 9 days of pollinator access.

We recommend further investigations of pollination with other species of flowering plants in order to perform a comparative analysis on the general pollination trend for all flowering species.

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